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### Production Device

The invention relates to a production device for execution of a blow molding, charging, and sealing process for plastic containers including at least a molding device of the first type into which at least one tube of plasticized plastic material may be introduced.

Generic processes and devices for production of plastic containers are known in the state of the art (DE 199 26 329 A1), ones in which a tube of plasticized plastic material is extruded into a molding device, one end of the tube is sealed by bonding and this tube is expanded by generation of a pneumatic pressure gradient which acts on the tube and is applied for the purpose of formation of the container to the molding wall of the molding device consisting of two opposite molding tools. The plastic container is charged under sterile conditions inside the molding device, by way of a suitable charging mandrel, and, after the charging mandrel has been removed, is then hermetically sealed and a predetermined head geometry is formed, with two container shaping jaws which may be moved toward each other by hydraulic drive means to obtain a closed position and away from each other over the same path in the opposite direction to their open position for formation of the plastic container itself for subsequent storage of the fluid.

The head geometries to be generated by means of the two controlled head jaws also regularly comprise the neck component of the plastic container, including that in the form of ampules, which may be opened by way of a point of separation closed by a head piece for a fluid removal process as soon as the head piece is separated by way of a toggle component by way of the point of separation and thus removed from the plastic container itself.

Processes such as these have been disclosed in a number of embodiments and are widely employed in packaging systems for liquid or paste products.

The hydraulic drive systems regularly used in practical applications for the respective movement of delivery of the shaping tool create problems in that any leakage may result in fouling by the fluid, something which leads to problems in particular when the shaping machines are used for plastic containers in pharmaceutical applications and in the area of foods and in medical technology in general. The maintenance effort is also increased and the hydraulic drive systems often do not reach the cycle times desired or low cycle times work to the detriment of precise positioning of the shaping tools for container shaping; in the case of the known production devices the blow molding, charging, and sealing process are carried out stationarily in temporal sequence in one production machine, so that correspondingly long production times are required for the entire production process.

So-called rotation plastic blow molding machines (EP-B-0 921 932, EP-B-0 858 878) which customarily have a wheel mounted on a base frame for rotation about a horizontal axis of rotation are known in the state of the art; they are employed in order to overcome the disadvantage indicated, and in particular to achieve faster cycle times in production of plastic containers. The wheel in question contains a frame which supports several molding stations each of which has a pair of mold frames for mounting of a pair on molding halves. The mold frames may be moved between a mold opening point at which the mold halves are positioned a certain

distance from each other in order to receive an extruded plastic parison and a mold closing position in which the mold halves form a closed cavity in which the parison is blow molded. However, the blow-molded containers can neither be charged nor sealed to be sterile by means of these rotation plastic blow molding machines of the state of the art, and accordingly are suitable only for production of empty containers which are provided at another site with a beverage content or the like outside the rotation molding machine and are also provided with a suitable seal such as a screw-type cap.

On the basis of this state of the art the object of the invention is to create a production device for execution of a blow molding, charging, and sealing process for plastic containers, a device which permits application of modern drive concepts, for example, in the form of electric or pneumatic drives the maintenance effort of which is reduced and in particular permits high rates of output of the goods to be produced, such as plastic containers. An object as indicated in the foregoing is attained with a production device having the characteristics specified in patent claim 1 in its entirety.

In that, as is specified in the characterizing part of claim 1, the respective molding device of the first type may be pivoted about an axis to individual spatially separate stations and in that at least one station serves the purpose of blow molding and at least one station that of charging and sealing the container blow-molded in this manner, it is possible at least simultaneously to blow-mold a tube of plasticized plastic material for production of the plastic container and to charge a container of this type already produced in this manner at the other station with the medium, in particular one in the form of a fluid and to seal this container. The output rates may be more or less at least doubled in the case of the respective assembly from the rate obtained with the known production devices for execution of a blow molding, charging, and sealing process, since now it is no longer necessary to carry out all individual processes such as blow molding, charging, and sealing at only one station within the known production device in order to obtain a

plastic container. By creating the individual production and processing station it also becomes possible to apply modern drive concepts and to control the individual molding devices by means of electric stepped drives so that fouling by a hydraulic medium or the like is avoided.

In that the individual production steps are divided among different stations, the safety and accuracy of processing is also improved in comparison to the known single-station production process, in which all production steps are carried out sequentially in one place (at one station) rather than simultaneously as in the case of the device claimed for the invention.

In one preferred embodiment of the production device claimed for the invention the respective tube of plasticized plastic material may be introduced into the molding device of the first type; at a second station following in the direction of pivoting this extruded tube consisting of plasticized plastic material may be subjected to blow molding to produce the container, it being possible to charge the blow-molded container and seal it under sterile conditions at a following third station and for removal from the mold of the respective blow-molded container charged and sealed under sterile conditions to be carried out at a following fourth station. In this way the entire production process for plastic containers is divided among four different stations, the production steps assigned to them being performed simultaneously at these stations. This results in very high cycling and rates of output of plastic products, even ones in the form of ampules, charged and sealed under sterile conditions.

In another preferred embodiment of the production device claimed for the invention the four stations are spaced radially at an angle of  $90^\circ$  from each other in the direction of pivoting, it being possible to pivot four molding devices of the first type in sequence to the respective stations. Consequently, the production stations are spaced at uniform radial distance over the circumference of the production device, so that only extremely short production pauses occur when the molding device of the first type is pivoted to the next production station. Provision

preferably is made such that the respective molding device of the first type may be pivoted about a vertical axis and such that the respective station is mounted so as to be stationary.

In another, especially preferred, embodiment of the production process claimed for the invention, there exists in addition to the molding device of the first type another device of the second type serving the purpose of sterile sealing of the respective plastic container on its open neck and head side by way of which the respective container may be charged with the fluid under sterile conditions. The molding device of the first type preferably is mounted below the molding device of the second type and the associated molding tools of the first and the second molding device form a common longitudinal axis which corresponds to the longitudinal axis of the container. In this way the molding device of the first type is pivoted as a whole with the molding device of the second type on the circumference of the associated molding tools (head jaws) something that keeps the pivoting and rotating masses low, so that not only may the production process be carried out safely with reduced centrifugal forces but also the drive power for the pivoting of the respective molding device is correspondingly reduced, this lowering both the production costs and the operating costs involved in use of the production device.

In another preferred embodiment of the production device claimed for the invention the respective molding device may be activated for moving at least one molding tool by means of a link control which moves the respective molding tool to a sealing position at least for sealing the mold, it being possible to actuate the link control by a drive, preferably in the form of the electric stepping motor. This permits uniform, safe, and position-accurate driving of the respective molding tool and requires only minor maintenance efforts. In addition, a plurality of opening and closing processes may be carried out in quick succession by the link control, this also favoring a high output of the goods to be produced.

It has been found to be especially advantageous for the production process to make provision such that the respective drive for the respective molding device of the first kind is stationary at least at part of the stations, it being possible to couple this molding device to the drive shaft of the drive by way of a coupling point. In the solution in question the drive is coupled to the molding device referred to only if this is necessary for an opening or closing process with the molding tools and, in particular during pivoting of the molding device to and from a station, the associated drive is not to be driven along with the molding device; this reduces the forces of inertia and accordingly the centrifugal forces and yields the advantages indicated in the foregoing. Provision preferably is made such that the drive shaft for the first molding device is mounted perpendicularly to its pivot axis, the other drive shaft of the other drive for the molding device of the second type extending in parallel with this pivot axis and this other drive being mounted at the third production station so as to be stationary, the function of this station being charging and sterile sealing of the container. In this way the molding device of the second type designed for an opening and closing process with its molding tools may be readily controlled, since, because of the different drive shafts, the associated drive systems with their different drives are situated on different planes inside the production device. At the third production station the molding tools of the molding device of the second type are pivoted in together with the molding device of the first type and, after the other drive has been actuated, the molding tools of the molding device of the second type may be moved to the sealing position after the container has been charged, sterile sealing of the contents of the container being carried out, along with shaping of the head component in this sealing position.

In another preferred embodiment of the production device claimed for the invention a laminar flow unit or a sterile barrier unit is present between the individual stations, a unit which covers the free openings of the molding device of the first type and accordingly the respective container openings in advance of sterile sealing of the container. This makes certain that fouling

particles will be prevented from entering the container opening with the fluid during the production process.

The production device claimed for the invention will now be described in greater detail below with the aid of exemplary embodiments illustrated in the drawings in which in diagrammatic form and not drawn to scale:

FIG. 1 shows a top view of the production device as a whole;

FIG. 2 shows a side view of the production device in the direction of the arrow X in FIG. 1 as viewed without discharge station;

FIG. 3 shows a top view of the molding device of the first type (described in detail in DE-A-103 17 711.6);

FIG. 4 shows a top view of a part of the molding device of the second type (described in detail in DE-A-103 17 712.4).

FIG. 1 shows a top view of the production device for execution of a blow molding, charging, and sealing process for plastic containers, including ampules, with molding devices 10. Tubes of a plasticized plastic material which may be produced by an extruder assembly designated as a whole as 12 may be introduced into the respective molding device 10. For this purpose granulated plastic is melted along a heated extruder section 14 and introduced by way of a discharge assembly 16 into the respective molding tools of the molding device 10 of the first type, if the tools are in their opened position for reception of the respective extrusion tube.

Consequently, ten extrusion tubes in a row, for example, may be received by molding device 10 of the first type. The respective molding device 10 may be pivoted in a horizontal plane about a vertically extending pivot axis 20 of the production device. In addition, the production device has four spatially separated stations 22, 24, 26, and 28, the first station 22 being available to receive the extrusion tubes as has been explained in the foregoing. The second station 24 performs the function of blow molding of extrusion tubes positioned side by side in a row by means of a blow molding assembly 30, which presses the individual plastic tubes by means of blast air against the mold walls of the molding tools of the molding device 10 of the first type in order to form containers. The respective blowing process may be supported by a vacuum, supporting air, or the like in the molding device of the first type. The next station 26 in the pivot direction performs the function of sterile charging of the plastic containers produced at the station 24, the ends of the containers being sealed after charging at the station 26. For this purpose the drive unit of a molding device 32 of the second type is used at the station 26 and the charging assembly 34 is mounted above the molding device 32 as shown facing the viewer in FIG. 1. The next station 28 following in the pivot direction performs the function of removal of molds from the blow-molded, charged, and sealed plastic containers, the containers when removed from the molding device 10 are pushed onto pallet lines 36, especially into packaging (not shown), for subsequent shipping.

As FIG. 1 also shows, the four stations 22, 24, 26, and 28 are spaced radially in sequence at an angle of 90° from each other in the pivot direction of the molding device 10 of the first type, inside the production device, it being possible to pivot four molding devices 10 of the first type together with the molding tools of the molding device of the second type in sequence into the respective stations 22, 24, 26, and 28. The production device shown in FIG. 1 may accordingly be used to carry out simultaneously all four different production operations such as receipt of extrusion tubes, blow molding, charging and sealing, and mold removal; this appreciably increases the cycle and output rate of plastic to be produced in relation to comparable



production devices in the state of the art which perform the treatment processes referred to sequentially at one station.

The respective molding device 10 of the first type is mounted so as to be pivotable counterclockwise about the vertical axis 20 and the respective stations 22, 24, 26, and 28 are positioned inside the production device so as to be stationary.

The configuration of the molding device 10 of the first type is to be seen in the top view shown in FIG. 3. The respective molding device is also described in detail in DE-A-103 17 711.6 issued to the applicant, so that only the basic structure of the molding device will be specified here. The molding device 10 as a whole performs the function of moving molding tools 40, 40a and on its free frontal surface the respective molding tool 40, 40a has trough-shaped recesses (not shown) which consequently form mold halves for generation of container geometries for plastic containers not shown, including ones in the form of ampules. The two molding tools 40, 40a work together to generate the respective container geometries; as is to be seen in FIG. 3, the two molding tools 40, 40a are in the closed, molding, position in which the free frontal surfaces of the molding tools come together along a closing separating line.

The function of moving the respective molding tool 40, 40a is performed as a whole by a link control component designated as a whole as 42 and actuated by a centrally mounted drive 44, only the splined shaft 46 of the drive 44 being shown in FIG. 3 for the sake of simplicity. The respective splined shaft 46 may be coupled by way of a coupling piece (not shown) such as a claw coupling to the driven shaft of an electric motor, for example, one in the form of an electric stepping motor which thus permits actuation of the link control component 42, the drive shaft of the molding device 10 pivoting on a common axis with the driven shaft of the drive 44 and the drive torque for the molding tools 40, 40a then being transmitted by way of the coupling. As is shown in FIG. 2, such a drive 44 is positioned centrally at least at the station 28 and at the station

22 for the purpose of opening the molding device to ensure execution of the process of removal from the mold and subsequent closing of the mold in order to permit seating of the respective extrusion tube formed by the extruder assembly 12 with its discharge assembly 16 and subsequently closing of the mold.

The link control component 42 has a slot guiding device 48 which is positioned on the external circumference side on a rotational element 50 which may be driven by the splined shaft 46. An actuating component 52 which operates in conjunction with a slot component 54 is engaged in the slot guiding device 48; when the slot guidance device 48 rotates from one of its end areas to its other end area and in the opposite direction the slot component 54 which may be associated may be moved with the molding tool 40, 40a by way of the thus longitudinally movable actuating component 52 from a closed position along closing line I - I into an open position (not shown) of the mold form by the respective molding tool 40, 40a and vice versa. Consequently, the molding tools 40, 40a may be moved in pairs simultaneously opposite a link control component 42 by way of the common drive components by drive 44 at the station provided for this purpose, so that four link control components in pairs opposite each other are actuated by a common operating shaft 56.

The drive unit of the molding device 32 of the second type is mounted at station 26 for each molding device 10 of the first type to be pivoted in and coming from the station 24; as seen in the line of sight to FIG. 2 the drive unit of the molding device 32 is mounted so as to be stationary and the respective molding device 10 of the first type may be pivoted below the drive unit of the molding device 32 of the second type into the station 26 by means of a central rotary drive (not shown), along the pivot axis 20 radially in a common horizontal plane 18. The molding tools 60 of the molding device 32 of the second type are moved along from the molding device 10 of the first type in the respective pivot movement. The respective molding device 32 of the second type is illustrated in detail at least in part in FIG. 4 and is also fully described in

DE-A-103 17 712.4, so that only the basic aspects of this molding device will be discussed at this point.

The molding device 32 of the second type shown in FIG. 4 performs the function of moving molding tools 60 having trough-like recesses 62 on their front side which thus form mold halves for generation of head geometries for plastic containers not shown. To generate the head geometries in question the respective molding tool 60 operates in conjunction with a corresponding molding tool with correspondingly configured recesses (not shown), the configuration shown in FIG. 4 is replicated correspondingly on the other side of the closing separating line I - I (not shown). The molding device 32 has for the purpose of moving the molding tool 60 a second link control component designated as a whole as 64 as drive unit by way of which the respective molding tool 60 may be actuated to close the mold along the closing line I - I, it being possible to actuate the other link control component 64 in turn by another drive 66, preferably in the form of an electric motor, for example, in the form of an electric stepping motor. For this purpose the other link control component 64 has a slot guide in a feed component 70 which is engaged by an actuating member 72 which may be moved into a position corresponding to the open and closed position I - I of the molding tool 60 by a rotary part 74 which may be actuated by the other drive 66. In this instance as well the molding tools 60 opposite each other forming a pair in turn may be moved synchronously by a link control component 64 into their closed position, two electric drives 66 opposite the closing separating line actuating two link control components 64 opposite each other forming a pair to move the molding tools 60.

As a result of superposition of the two molding devices 10 and 32 at the station 26, the latter with its molding tools 10, 60 form a common longitudinal axis which corresponds to the longitudinal axis of the container, the drive unit 64, 66 of the molding device 32 remaining at the station 26 while the molding tools 60 of the device 32 are brought to the station 26 with the

respective molding device 10, at which the drive unit 64, 66 moves the molding tools 60 to the sealing position, and the molding device 10 at the station 26 as viewed in the line of sight to FIG. 2 remaining below the molding device 32.

Consequently, in the configuration in question the drive shaft for the first molding device 10 is mounted so as to extend perpendicularly to its pivot axis 20, while the other drive shaft of the other drive 66 for the molding device 32 of the second type extends in parallel with this pivot axis 20. In addition, the other drive 66 is mounted on the second molding device 32 so as to be stationary. In addition, there is positioned between the individual stations 22, 24, 26, and 28 a laminar flow unit or sterile barrier (not shown) which covers the free openings of the molding device 10 of the first type and accordingly the respective container opening in advance of its sterile sealing.

Use of the production device claimed for the invention and distribution of different molding steps among different stations creates a sort of carrousel configuration which permits very high cycle frequencies for output of the plastic material in the form of containers. The hygienic requirements are to a great extent satisfied by the use of electric drives and in particular the production device itself with its stations is hermetically sealed off from the extruder assembly which separates the plasticized plastic material, so that clean room conditions may be created for the blow molding, charging, and sterile sealing process itself, should this be desired by the user.